

Description

Self-Aligning Insert for Drill Bits

BACKGROUND OF INVENTION

[0001] 1. Field of the Invention.

[0002] The present invention is generally directed to the field of roller cone drill bits, and, more particularly, to a self-aligning insert that may be used on a roller cone drill bit.

[0003] 2. Description of the Related Art.

[0004] Oil and gas wells are formed by a rotary drilling process. To that end, a drill bit is mounted on the end of a drill string which may be very long, e.g., several thousand feet. At the surface, a rotary drive mechanism turns the drill string and the attached drill bit at the bottom of the hole. In some cases, a downhole motor may provide the desired rotation to the drill bit. During drilling operations, a drilling fluid (so-called drilling mud) is pumped through the drill string and back up-hole by pumps located on the surface. The purpose of the drilling fluid is to, among other things, remove the earthen cuttings resulting from

the drilling process.

[0005] Figure 1 depicts an exemplary rolling cutter rock drill bit 10 within which the present invention may be used. A "rolling cutter rock drill bit" is also commonly called a rock bit, a rolling cutter drill bit or an oilfield drill bit. The illustrated bit 10 includes a body 12 having three legs 14. In this type of bit, as is known in the art, a cantilevered bearing spindle (not shown in Figure 1) formed on each leg 14 extends inwardly and downwardly and is capable of carrying a rotatably mounted rolling cutter 18. A plurality of bearings are arranged on the bearing spindle to support the rotatably mounted rolling cutter 18. Attached to each illustrated rolling cutter 18 are hard, wear-resistant cutting inserts 20, which are capable of engaging the earth to effect a drilling action and cause rotation of the rolling cutter 18.

[0006] The inserts 20 on the rolling cutters 18 crush and cut the rock as drilling operations are performed with the necessary force being supplied by the "weight-on-bit"(WOB) which presses down on the drill bit 10 and by the torque applied by the rotary drive mechanism. During the drilling process, very large and non-constant stresses and forces may be applied to the inserts 20, the rolling cutters 18,

and the drill bit 10 itself. The cutting inserts 20 typically have a generally cylindrical shape and a generally circular cross-sectional configuration. The cutting inserts 20 are received by sockets, or insert holes, drilled into the rolling cutter 18, perpendicular to the surface of the rolling cutter 18 body. A plurality of insert holes drilled along the same radius of a band to form a row of insert holes on that band. The cutting inserts 20 are held in place in the sockets by an interference fit.

[0007] To provide an interference fit between the cutting insert 20 and the socket, the socket is formed with a diameter slightly smaller than that of the cylindrical body of the cutting insert 20. The cutting insert 20 is then pressed into the socket and retained by the contact force between the socket wall and the outer wall surface of the cylindrical body of the cutting insert. Because the diameter of the insert 20 is greater than the inside diameter of the socket, and because of the hardness of the cutting insert material, e.g., tungsten carbide, the installation procedure can be difficult and can damage the socket. A damaged socket can reduce the contact force between the cutting insert 20 and the socket wall. If the socket becomes sufficiently damaged during installation, the cutting insert 20 can

dislodge from the socket during drilling operations. Additionally, a damaged socket can also allow the cutting insert 20 to rotate in the socket during drilling, which can decrease the cutting effectiveness of the cutting insert 20.

[0008] As indicated above, inserts 20 are typically pressed into an opening or socket formed in the body of the rolling cutter 18. The installation process typically involves the use of very powerful presses to force the insert 20 into the opening or socket formed in the rolling cutter 18 body. By way of example, Figure 3 depicts an illustrative insert 20 comprised of a generally cylindrical body 61, a cutting surface 62, a bottom surface 63, a tapered surface 64, and a rounded or radiused corner 65 that provides the transition between the tapered surface 64 and the bottom surface 63. Typically, the tapered surface 64 is formed at an angle of approximately 15 degrees relative to the centerline 67 of the cylindrical body 61 of the insert 20.

[0009] Using existing inserts, such as the insert 20 depicted in Figure 3, it is frequently difficult and time-consuming to insure that the insert 20 is properly aligned with an opening 70 (see Figure 4) formed in the rolling cutter body 18a prior to pressing the insert 20 into the opening 70. As depicted in Figure 4, the insert 20 may be misaligned, e.g.,

tilted, relative to the centerline 72 of the opening 70. Depending upon the particular application, such misalignment could cause many severe problems as it relates to the installation of the insert 20 in the opening 70. For example, depending upon the magnitude of the misalignment, the insert 20 could cut or damage the entrance of the opening 70 thereby lessening the effectiveness of the interference fit between the insert 20 and the opening 70. Accordingly, manufacturers have resorted to a variety of techniques and methods in an attempt to overcome or reduce the problems associated with the misalignment of the insert 20 with the opening 70 formed in the cutter body 18a. To that end, in some applications, a guide device (not shown) would be positioned around the opening 70 to assist in aligning the insert 20 with the centerline 72 of the opening 70. However, in some applications, there is insufficient room for the use of such guide devices. In other cases, manual efforts were used in an attempt to properly align the insert 20 with the opening 70 prior to performing the pressing operations. Such activities included grasping the insert 20 with a tong-like tool in an effort to maintain the proper alignment of the insert 20 as the pressing operation is begun. Such manual activities

relating to the alignment of the insert 20 with the opening 70 are time-consuming, expensive, and may lead to inconsistent results as related to the quality of the installation of the insert 20 in the opening 70.

[0010] The present invention is directed to devices and methods that may solve, or at least reduce, some or all of the aforementioned problems.

SUMMARY OF INVENTION

[0011] The present invention is generally directed to various embodiments of a self-aligning insert for use with roller cone drill bits. In one illustrative embodiment, the insert comprises a generally cylindrical body, a cutting surface, a bottom surface, a tapered surface adjacent the generally cylindrical body, and a generally cylindrical section positioned between the bottom surface and the tapered surface. Cutter inserts in accordance with the present invention may be installed in the roller cones of roller cone drill bits.

[0012] In another illustrative embodiment, the insert comprises a generally cylindrical body, a cutting surface, a bottom surface, a tapered surface adjacent the generally cylindrical body, a radiused corner region adjacent the bottom surface, and a generally cylindrical section positioned be-

tween the radiused corner region and the tapered surface, wherein the radiused corner region defines a transition between the bottom surface and the generally cylindrical section.

[0013] In yet another illustrative embodiment, the insert comprises a generally cylindrical body, a cutting surface, a bottom surface, a tapered surface adjacent the generally cylindrical body, a radiused corner region adjacent the bottom surface, a generally cylindrical section positioned between the radiused corner region and the tapered surface, wherein the radiused corner region defines a transition between the bottom surface and the generally cylindrical section, and a radiused region positioned between the tapered surface and the generally cylindrical section, wherein the radiused region defines a transition between the generally cylindrical section and the tapered surface.

[0014] In a further illustrative embodiment, the insert comprises a generally cylindrical body, a cutting surface, a bottom surface, a tapered surface adjacent the generally cylindrical body, and a region of material positioned between the bottom surface and the tapered surface, the region of material positioned outside of a volume defined, at least in part, by an intersection of a linear extension of the ta-

pered surface with the bottom surface.

[0015] In yet a further illustrative embodiment, the insert comprises a generally cylindrical body, a cutting surface, and a bottom portion extending from the generally cylindrical body, the bottom portion comprising a bottom surface and a tapered surface, the tapered surface being formed adjacent the generally cylindrical body, wherein the bottom portion is configured such that there is a region of material positioned between the bottom surface and the tapered surface, the region of material being positioned outside of a volume defined, at least in part, by an intersection of a linear extension of the tapered surface with the bottom surface.

BRIEF DESCRIPTION OF DRAWINGS

[0016] The invention may be understood by reference to the following description taken in conjunction with the accompanying drawings, in which like reference numerals identify like elements.

[0017] Figure 1 is a perspective view of a prior art rolling cutter drill bit.

[0018] Figure 2 is a cross-sectional view of a prior art rolling cutter drill bit.

[0019] Figure 3 is a side view of an illustrative prior art insert that

may be installed in the rolling cutter drill bit depicted in Figure 1.

[0020] Figure 4 depicts an illustrative misalignment between the insert depicted in Figure 3 when it is installed in an opening formed in one of the rolling cutters of the drill bit depicted in Figure 1.

[0021] Figure 5 is a side view of an illustrative insert in accordance with one illustrative embodiment of the present invention.

[0022] Figure 6 is an enlarged view of a portion of one illustrative embodiment of an insert in accordance with the present invention.

[0023] Figure 7 is a side view that compares one illustrative embodiment of the present invention with a prior art insert.

[0024] While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as de-

fined by the appended claims.

DETAILED DESCRIPTION

[0025] Illustrative embodiments of the invention are described below. In the interest of clarity, not all features of an actual implementation are described in this specification. It will, of course, be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

[0026] The present invention will now be described with reference to the attached drawings which are included to describe and explain illustrative examples of the present invention. The relative size of the various features shown in the drawings may not be to scale, as some features may be exaggerated for purposes of explanation. The words and phrases used herein should be understood and interpreted to have a meaning consistent with the understand-

ing of those words and phrases by those skilled in the relevant art. No special definition of a term or phrase, i.e., a definition that is different from the ordinary and customary meaning as understood by those skilled in the art, is intended to be implied by consistent usage of the term or phrase herein. To the extent that a term or phrase is intended to have a special meaning, i.e., a meaning other than that understood by skilled artisans, such a special definition will be expressly set forth in the specification in a definitional manner that directly and unequivocally provides the special definition for the term or phrase.

[0027] The present invention will now be described with reference to Figures 5 and 6. Figure 5 is a side view of an illustrative insert 100 in accordance with one embodiment of the present invention. Figure 6 is an enlarged view of a portion of the insert 100 as a portion of the insert 100 is positioned in an opening 110 formed in an illustrative cutter body 120. As indicated in Figure 5, the insert 100 is generally comprised of a generally cylindrical body or shank 101, a bottom surface 102, and a cutting surface 103. The insert 100 further comprises a radiused corner region 104, a generally cylindrical section 105, a radiused region 106 and a tapered surface 107. In a general sense,

the insert 100 may comprise a cutting surface 103, a generally cylindrical body 101, and a lower portion 108, i.e., the portions of the insert extending below the generally cylindrical body 101. The generally cylindrical section 105 may be a true cylindrical section or it may have a very slight taper, e.g., up to approximately 5 degrees or so, for manufacturing reasons. For example, such a slightly tapered generally cylindrical section 105 may be employed such that a punch used to manufacture the insert 100 can be removed without damaging the insert 100. As used herein, the phrase "generally cylindrical section" shall be understood to include a true cylindrical section as well as a slightly tapered section that is tapered for manufacturing reasons. As will be recognized by those skilled in the art after a complete reading of the present application, the present invention has broad applicability and thus should not be considered as limited to the embodiments specifically disclosed herein. For example, the cutting surface 103 of the insert 100 may be of any desired shape or configuration. Typically, the insert 100 is comprised of a tungsten carbide material, although it may be made from other materials if desired.

[0028] Figure 6 is an enlarged view of a portion of the insert 100

as it is positioned in an opening 110 in a cutter body 120. In this illustrative example, the opening 110 has chamfered corners 111 adjacent the bottom of the opening 110. In one illustrative embodiment, the bottom surface 102 of the insert 100 extends beyond the generally cylindrical body or shank 101 by a depth 112 of approximately 0.050 inches. Of course, the depth 112 of the bottom portion 108 may vary depending upon the particular application. In one illustrative embodiment, the tapered surface 107 is formed at an angle 113 of approximately 15 degrees relative to a centerline 109 of the insert 100. In one illustrative embodiment, the radiused region 106 provides a transition from the tapered surface 107 to the generally cylindrical surface 105. In one particularly illustrative embodiment, the radiused region 106 has a radius of approximately 0.020 inches and an included angle of approximately 15 degrees. Similarly, in one embodiment, the radiused corner 104 provides a transition between the bottom surface 102 of the insert 100 and the generally cylindrical section 105. If a taper is provided on the generally cylindrical section 105, it will be less than the tapered angle 113 of the tapered surface 107. In one particularly illustrative embodiment, the radiused corner region

104 has a radius of approximately 0.020 inches and an included angle of approximately 90 degrees.

[0029] As described above, the insert 100 will be press-fit into the opening 110 to secure the insert 100 therein. Accordingly, the body 101 of the insert 100 has a diameter 101D that is somewhat greater than the diameter of the generally circular opening 110. In one illustrative embodiment, the diameter 101D of the insert body 101 may be approximately 0.316 inches, whereas the opening 110 may have a diameter of approximately 0.312 inches. Of course, the physical size of the insert body 101 as well as the opening 110 may vary depending upon the particular application. In the illustrative embodiment depicted herein, the generally cylindrical section 105 has a diameter 105D of approximately 0.307 inches resulting in a clearance 114 of approximately 0.009 inches. Of course, the clearance 114 may vary depending upon the particular application. In some illustrative embodiments, the clearance 114 may be approximately 0.007–0.012 inches. The axial length of the generally cylindrical section 105 may also vary depending upon the application and the depth 112 of the lower portion 108. In one illustrative embodiment, the generally cylindrical section 105 has an axial length, i.e., a

length approximately parallel to the centerline 109 of the insert 100, of approximately 0.020 inches. In some applications, the axial length may vary from approximately 0.010 inches to 0.050 inches. The opening 110 may be formed in any region of a cutter body, and it may have a generally circular configuration. In some cases, the opening 110 may be formed directly in the curved surface 110A of a roller cone body. In other cases, the surface 110A depicted in Figure 6 may be a flat surface. That is, the present invention may be employed in applications where a generally flat surface is provided around the perimeter of the opening 110. Such a situation may occur where the opening 110 is formed in a countersink area of the rolling cutter body. Thus, the present invention should not be considered as limited to its use with respect to the installation of inserts 100 at any particular region or location in a rolling cutter body.

[0030] Figure 7 is provided to depict at least some of the differences between an insert 100 in accordance with one illustrative embodiment and at least some prior art cutting inserts. The solid lines in Figure 7 depict an insert 100 in accordance with one illustrative embodiment of the present invention. As shown therein, the insert 100 is

comprised of the rounded corner region 104, the generally cylindrical section 105, the radiused region 106 and the tapered surface 107. Also depicted in Figure 7 is a dashed line which indicates a portion of the structure of the prior art insert 20 depicted in Figures 3 and 4. Specifically, the tapered surface 64 and rounded corner 65 of the insert 20 depicted in Figure 3 are indicated by the dashed lines. As can be seen in Figure 7, the bottom portion 108 of an insert 100 in accordance with one embodiment of the present invention comprises a bump 130, or region of additional material, as compared to the prior art insert depicted in Figures 3 and 4. More specifically, this region of material 130 is positioned between the bottom surface 102 and the tapered surface 107 and lies outside of a volume defined, at least in part, by an intersection of a linear extension of the tapered surface 107 with the bottom surface 102. Stated another way, the bottom portion 108 of the insert 100 is configured such that this region of material 130 is positioned at some location between the bottom surface 102 and the tapered surface 107. Of course, by stating that the region of material 130 is between the bottom surface 102 and the tapered surface 107, it should be understood that, in some applications, the re-

gion of material 130 may extend to and contact the tapered surface 107 and/or the bottom surface 102. Transition regions, e.g., radiused regions, may also be provided between the region of material 130 and the bottom surface 102 and/or the tapered surface 107.

[0031] This additional region of material or bump 130 provides many advantages as it relates to the alignment of the insert 100 with an opening formed in the cutter body. More specifically, due to the presence of the region of material 130, the misalignment between the centerline 109 of the insert 100 and the centerline of the opening 110 may be limited to, in one illustrative embodiment, approximately 6–8 degrees. That is, as the misalignment between the insert 100 and the opening 110 approaches this 6–8 degree value, the bump 130 engages portions of the interior surface 115 (see Figure 6) of the opening 110, thereby limiting the degree of misalignment. Moreover, due to the presence of the bump 130, and perhaps the radiused corner region 104, a relatively slight axial force 140 applied to the end of the insert 100 tends to cause the insert 100 to become more aligned with the centerline of the opening 110. Accordingly, inserts in accordance with the present invention may be readily aligned and installed

without the need for prior art guide devices and/or the use of manual labor to attempt to properly align the insert as the insert is being inserted into the opening 110. Of course, if desired, a guide device may also be employed with inserts 100 of the present invention. Once the pressing operations are begun, and the insert body 101 is at least partially positioned within the opening 110, the pressing operations may be continued to fully install the insert 100 in the opening 110.

[0032] The present invention is generally directed to various embodiments of self-aligning insert for use with rolling cutter drill bits. In one illustrative embodiment, the insert comprises a generally cylindrical body, a cutting surface, a bottom surface, a tapered surface adjacent the generally cylindrical body, and a generally cylindrical section positioned between the bottom surface and the tapered surface. The inserts described herein may be installed in openings formed in the roller cone bodies of a roller cone drill bit.

[0033] In another illustrative embodiment, the insert comprises a generally cylindrical body, a cutting surface, a bottom surface, a tapered surface adjacent the generally cylindrical body, a radiused corner region adjacent the bottom

surface, and a generally cylindrical section positioned between the radiused corner region and the tapered surface, wherein the radiused corner region defines a transition between the bottom surface and the generally cylindrical section.

[0034] In yet another illustrative embodiment, the insert comprises a generally cylindrical body, a cutting surface, a bottom surface, a tapered surface adjacent the generally cylindrical body, a radiused corner region adjacent the bottom surface, a generally cylindrical section positioned between the radiused corner region and the tapered surface, wherein the radiused corner region defines a transition between the bottom surface and the generally cylindrical section, and a radiused region positioned between the tapered surface and the generally cylindrical section, wherein the radiused region defines a transition between the generally cylindrical section and the tapered surface.

[0035] In a further illustrative embodiment, the insert comprises a generally cylindrical body, a cutting surface, a bottom surface, a tapered surface adjacent the generally cylindrical body, and a region of material positioned between the bottom surface and the tapered surface, the region of material positioned outside of a volume defined, at least in

part, by an intersection of a linear extension of the tapered surface with the bottom surface.

[0036] In yet a further illustrative embodiment, the insert comprises a generally cylindrical body, a cutting surface, and a bottom portion extending from the generally cylindrical body, the bottom portion comprising a bottom surface and a tapered surface, the tapered surface being formed adjacent the generally cylindrical body, wherein the bottom portion is configured such that there is a region of material positioned between the bottom surface and the tapered surface, the region of material being positioned outside of a volume defined, at least in part, by an intersection of a linear extension of the tapered surface with the bottom surface.

[0037] The particular embodiments disclosed above are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. For example, the process steps set forth above may be performed in a different order. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular

embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the invention. Accordingly, the protection sought herein is as set forth in the claims below.